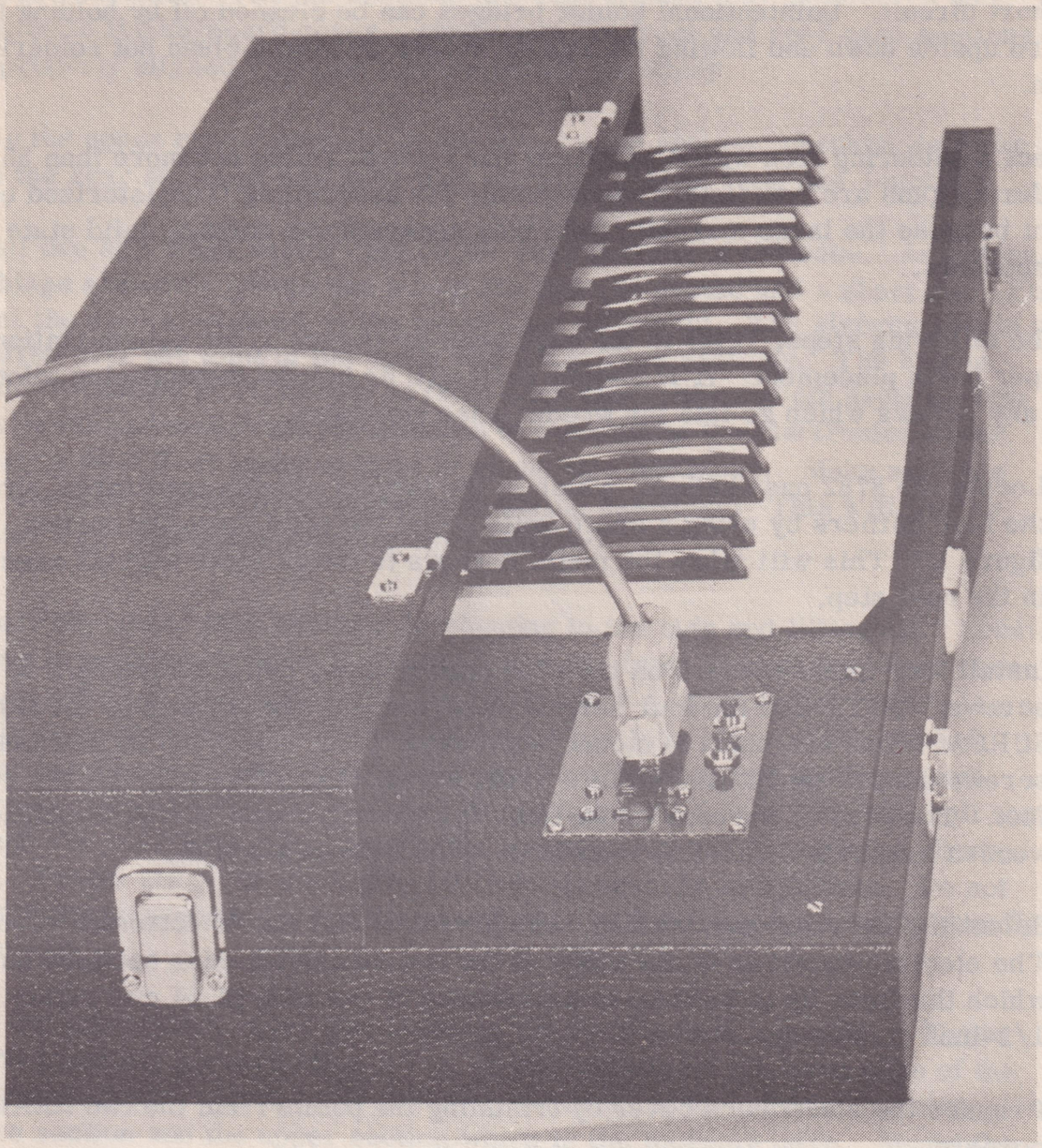
PAIA®

ELECTRONICS, INC.

8782

DIGITALLY ENCODED KEYBOARD



An n key roll-over scanning matrix encoder tied to a 37 note AGO keyboard provides 6 bits of data and both STROBE and STROBE control outputs. Input control lines to the encoder include SCAN (starts and stops encoder clock), RESET, START and RANDOM making the keyboard universally applicable to all computer/processors from the very largest to the very smallest.

SOLDERING

Use care when mounting all components. Use only rosin core solder (acid core solder is never used in electronics work.) A proper solder joint has just enough solder to cover the round solering pad and about 1/16-inch of the lead passing through it. There are two improper connections to beware of: Using too little solder will sometimes result in a connection which appears to be soldered but actually there is a layer of flux insulating the component lead from the solder bead. This situation can be cured by reheating the joint and applying more solder. If too much solder is used there is the danger that a conducting bridge of excess solder will flow between adjacent circuit board conductors forming a short circuit. Unintentional solder bridges can be cleaned off by holding the board upside down and flowing the excess solder off onto a clean hot soldering iron.

Select a soldering iron with a small tip and a power rating not more than 35 watts. Soldering guns are completely unacceptable for assembling transistorized equipment because the large magnetic field they generate can damage solid state components.

In the following steps, refer to the case blow-up (figure 1) for determination of proper parts placement. A 1/16-inch drill will be helpful in producing pilot holes for any screws which go into the wooden case structure.

( ) Locate the 8782 case bottom, which is the largest wooden structure. Prepare the four corners by using a sharp knife to cut the point from the corner. (See figure 1.) This will allow the metal corners to mount flush with all case sides in the next step.

( ) Install four metal corners on the 8782 case bottom, using twelve #4 X 3/8" screws. NOTE that the four screws used to mount the corners to the BOTTOM SURFACE are also used to mount four rubber feet. ALSO NOTE that the two screws used to mount the corners to the REAR SURFACE will hold two rubber feet. The rear of the case is the longest edge which does not have additional wooden mounting structures next to it. (See figures 1 and 6).

( ) Select the top rear case section, which we will call the "electronics cover". The electronics cover is the wider of the two remaining case sections on which the front lip is built up to a thickness of one inch (2.54 cm) rather than 1/2-inch (1.26 cm).

( ) Prepare the electronics cover by trimming the points from the two REAR corners.

( ) Using six #4 X 3/8" metal screws, mount two metal corners on the electronics cover where the corners have been trimmed. NOTE that the two screws used to mount the corners to the REAR case surface are also used to mount two rubber feet.

( ) Locate the remaining case section, which will be called the "keyboard cover". Prepare the two front corners of the keyboard cover by trimming the points from the corners.

( ) Mount two metal corners over the trimmed corners of the keyboard cover. Use six #4 X 3/8" screws to mount this hardware.

( ) Place the two upper case sections on a sturdy work surface with the edges butted together. Using eight #4 X 3/8" screws, install two slip hinge assemblies 3" (7.62 cm) in from each side. Note that one assembly should use a hinge with a long pin, the other a hinge with a short pin. Both pin sections hould be mounted to the keyboard cover. Both sleeve sections should be mounted to the electronics cover. The sleeve sections should be mounted first, with the sleeve itself being centered over the joint of the two case sections. The pin sections are then slipped into the sleeves and mounted to the keyboard cover. Make sure the front and rear case sections are properly aligned with one another during assembly.

( ) Place the upper case assembly on the lower case section, checking to make sure the rear surfaces (the ones with installed rubber feet) are together.

( ) Install two slip hinge assemblies on the rear surface of the case. As before, one hinge assembly should use a long pin and one should use a short pin. First, mount the sleeve sections on the lower case assembly. The sleeves should be centered over the joint of the upper and lower case sections. The hinges should be located 3" (7.62 cm) in from each side. Slip the pin sections into the sleeves and mount the pin sections to the rear of the electronics cover. Use eight #4 X 3/8" metal screws to mount this hardware. Make sure the case sections remain properly aligned during assembly. This will insure that the case will close properly when finished.

( ) Remove the upper case sections by slipping to the side and lifting off. Locate the two predrilled handle mounting holes on the front edge of the lower case section and clear the vinyl from these holes with a sharp knife. Mount the handle in these holes, noting that the handle has four pieces: the molded rubber handle, a metal strap inside the rubber handle, and the two metal end caps. The handles are mounted by passing a #8 X 3/4" flat head bolt through through the metal end cap, through the plastic strap and through the plywood case. Fasten the strap assembly with #8 lockwashers and #8 nuts. Do not overtighten these nuts, or the metal end caps will deform and restrict handle movement.

( ) Slide the electronics cover into place on the case bottom assembly. Mount a latch assembly on each side, 1" (2.54 cm) back from the front edge of the electronics cover. Each latch assembly consists of two parts: the lower square section and the upper section which is the movable latch. Mount the lower latch section on the bottom case assembly so the top edge is even with the joint of the two case sections. Then mount the upper latch section on the electronics cover. Make the latch somewhat tight to avoid accidental unlatching. Use eight #4 X 3/8" screws to mount these latches.

( ) Slip the keyboard cover back onto the case and close the cover. Mount two latch assemblies on the front edge of the 8782 assembly. The latches should be 3" (7.62 cm) in from either side, and each should be mounted using four #4 X 3/8" metal screws. Mount the lower latch sections on the lower case section before mounting the spring latch to the keyboard cover section. Make these latches have a tight fit when opening and closing. This will help keep the keyboard from accidentally opening while it is being carried.

POWER SUPPLY ASSEMBLY

( ) Open all latches and remove the top half of the case. With the bottom half of the case in front of you so you are looking at the case front, mark two points in the left rear section on the case bottom panel. Mark one point 8-1/4 inches (21 cm) from the left side and 1-3/8 inches (3.5 cm) from the case back. Mark another point 10 inches (25.4 cm) from the left side and 1-3/8 inches (3.5 cm) from the case back. These points should be made with reference to the inside edges of the case side and back. Use a 1/6 inch drill or awl to start the pilot holes at these points.

( ) Prepare the power transformer (T1) by cutting all five transformer leads to a length of 2" (5.1 cm). Prepare the leads by stripping 1/4" (7 mm) of insulation from the end and twisting the loose stranded wire together. Tin the leads by melting a small amount of solder into the exposed ends of the leads.

( ) Prepare the AC line cord by separating the two wires to a point 1" (2.54 cm) from the end of the line cord. Strip 1/4" (7 mm) of insulation from the end of each lead. Twist the exposed strands together before tinning each of the two leads.

( ) Locate the nylon cable clamp and place it around the AC line cord at a point 4" (10.2 cm) from the prepared end of the line cord.

( ) Using one #4 X 3/8" metal screw and one #6 flat washer, mount the clamp/line cord assembly and one end of the power transformer (T1) to the case bottom. Note the orientation of cable clamp, transformer, and leads as shown in power supply detail figure 2.

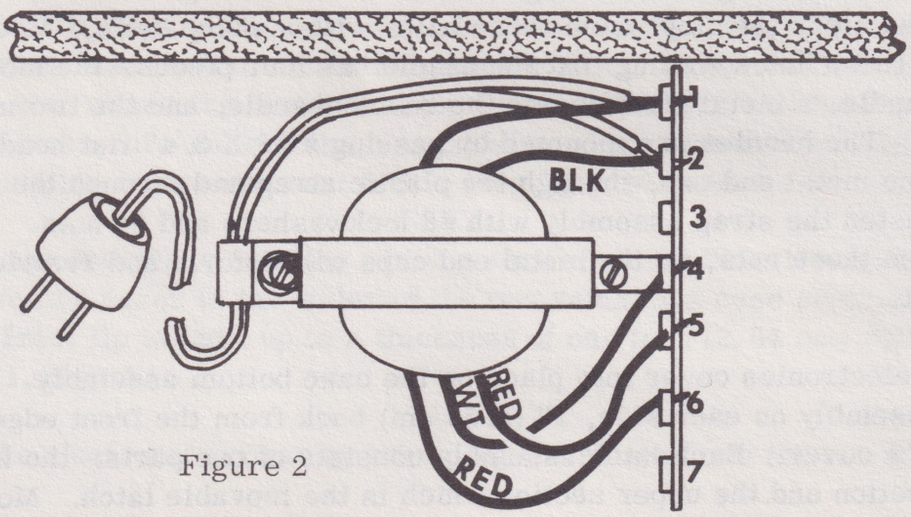


Figure 2

( ) Locate the 9-lug terminal strip. Using a pair of diagonal cutters, or other suitable tool, cut one terminal from each end of the strip. The terminal strip should now look like figure 3.

( ) Using one #4 X 3/8" metal screw, mount the previously prepared terminal strip and the remaining end of the power transformer (T1) as shown in figure 2.

( ) Connect one of the black transformer leads to lug #1 of the terminal strip. Do not solder at this time.

( ) Connect the remaining black transformer lead to lug #2 of the terminal strip. Do not solder.

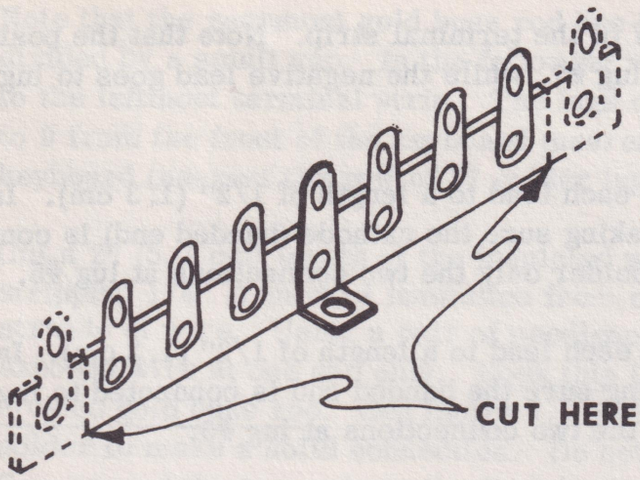


Figure 3

( ) Connect one lead of the AC line cord to lug #1 of the terminal strip. Solder two wires at this point.

( ) Connect the remaining lead of the AC line cord to lug #2 of the terminal strip. Solder two wires at this lug.

( ) Connect the center tap (middle lead) of the power transformer secondary to lug #4 of the terminal strip. This should be the lug which is part of the mounting bracket. Do not solder this connection at this time.

( ) Connect one of the outer secondary leads of T1 to lug #5 of the termianl strip. Do not solder at this time.

( ) Connect the remaining secondary lead to lug #6 of the terminal strip. Do not solder.

During the following component installation, refer to figure 4.

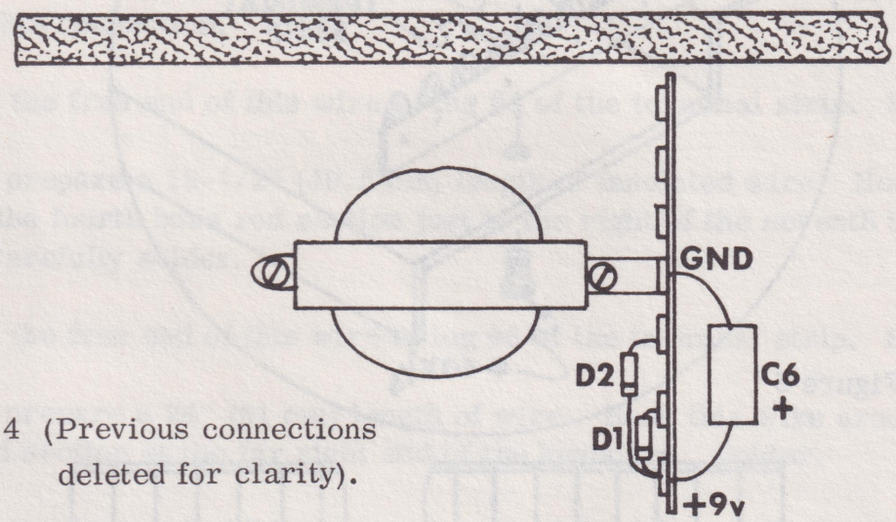


Figure 4 (Previous connections deleted for clarity).

( ) Clip each lead of C6 (220 mfd. or 250 mfd., 10 volts or higher) to a length of 3/4" (2 cm) from the body of the capacitor.

( ) Install C6 between lugs #4 and #7 of the terminal strip. Note that the positive lead of C6 must be connected to lug #7, while the negative lead goes to lug #4. Do not solder at this time.

( ) Prepare D1 (1N4003) by clipping each lead to a length of 1/2" (1.3 cm). Install D1 between lug #5 and lug #7, making sure the cathode (banded end) is connected to lug #7. Orient as shown and solder only the two connections at lug #5.

( ) Prepare D2 (1N4003) by clipping each lead to a length of 1/2" (1.3 cm). Install D2 between lugs #6 and #7, making sure the banded end is connected to lug #7. Orient as shown and solder only the two connections at lug #6.

This completes primary assembly of the 8782 case. Set this assembly aside while proceeding with following sections.

8782 KEYBOARD SUBASSEMBLY

( ) Locate the keyboard assembly and set it on your workspace upside down with the rear of the keyboard facing you.

( ) At the extreme left and right ends of the metal keyboard mainframe, note that there is a small hole which is approximately halfway between the front and rear edges of the mainframe. Using two #4-40 X 1/4" machine screws, two #4 lockwashers, and two #4-40 nuts, mount the two 9-lug terminal strips as shown in figure 5.

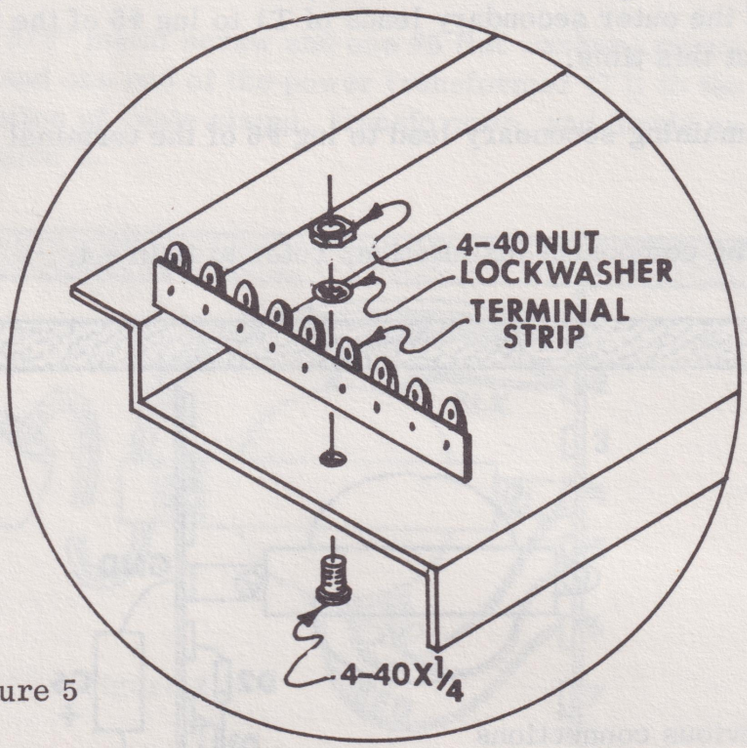
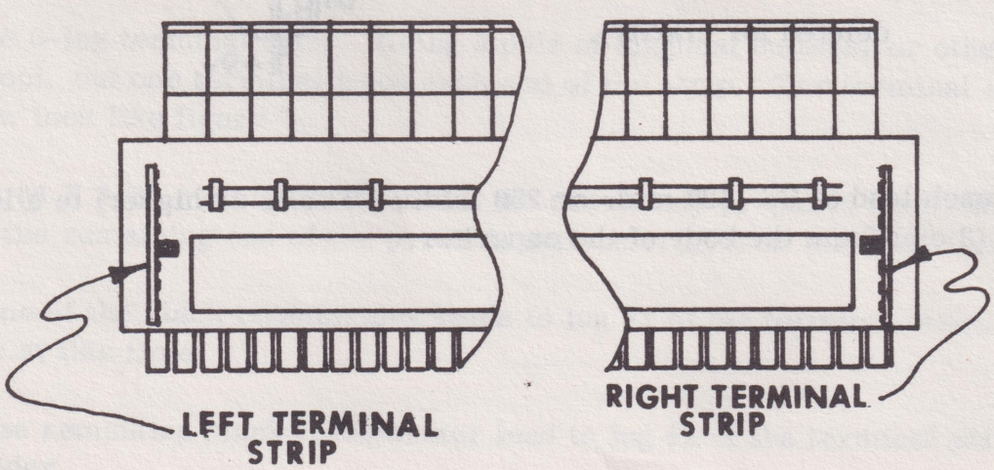


Figure 5



( ) Note that the rearmost gold buss rod has been divided into five sections, each divided by a small gap. In the following steps, these sections will be connected to the leftmost terminal strip. The lugs on the terminal strip and numbered 1 to 9 from the front of the keyboard (nearest the gold bus rods) to the rear of the keyboard (nearest the row of 37 solder lugs on the keyboard.)

( ) Cut a 2" (5.1 cm) length of the insulated wire provided. Prepare the wire by stripping 1/4" (7 mm) of insulation from each end. Twist and tin the exposed strands of wire. Using a pair of needlenose pliers, form a small U with the exposed wire at one end only. Hook this U over the extreme left end of the divided gold buss rod. See figure 7. Solder this connection. Use only enough solder to make a solid connection. Do not allow excess solder or rosin flux to flow around the area where the first keyspring contacts the buss rod. This condition will cause improper keyboard operation after completion. If rosin flux should flow down the buss rod, it can be removed with acetone or isopropyl alchohol and a cotton swab. Attention to detail and careful work while building the keyboard will reward you with trouble-free performance in the future.

( ) Connect the free end of the previously connected wire to lug #2 of the left terminal strip. You may solder this connection, however solder the wire to the lower half of the solder lug hole. This will leave a space at the top of the lug where an additional wire can be added later.

( ) Cut and prepare (as before) a 7-1/2" (19.1 cm) length of insulated wire. Hook this wire over the second buss rod section just to the right of the third plastic support post from the left. Carefully solder this connection.

( ) Connect the free end of this wire to lug #3 of the left terminal strip. As before, solder this connection leaving room for an additional wire to be added later.

( ) Cut and prepare a 12" (30.5 cm) length of wire. Hook this wire around the third buss rod section just to the right of the fifth plastic buss rod support. Carefully solder this connection.

( ) Connect the free end of this wire to lug #4 of the terminal strip. Solder.

( ) Cut and prepare a 19-1/2" (49.5 cm) length of insulated wire. Hook this wire around the fourth buss rod section just to the right of the seventh buss support post. Carefully solder.

( ) Connect the free end of this wire to lug #6 of the terminal strip. Solder.

( ) Cut and prepare a 24" (61 cm) length of wire. Hook this wire around the fifth buss rod section at the far right end of the keyboard. Solder.

( ) Connect the free end of this wire to lug #7 of the left terminal strip. Solder.

( ) If you have not done so as you were working, carefully route the five previously installed wires through the space between the buss rod supports and the front flange of the keyboard mainframe. Check to make sure the wires do not inhibit the motion of any of the delicate keysprings.

( ) The lugs on the rightmost terminal strip are numbered similarly to the left terminal strip. Lug #1 is closest to the front of the keyboard, lug #9 is closest to the rear edge of the keyboard. In the following steps, wires will be connected to these lugs. As before, solder these wires near the bottom of the solder lugs holes such that additional wires can be added later.

( ) Cut a 6" (15.3 cm) length of insulated wire. Prepare the wire by stripping 1/4" (7 mm) of insulation from each end. Twist the strands together and tin them by flowing a small amount of solder into the strands. Connect one end of this prepared wire to lug #1 of the right terminal strip. Solder. Route the wire towards the rear of the keyboard and let it hang. The free end of this wire will be connected later.

( ) Cut and prepare a 4-1/2" (12.7 cm) length of insulated wire. Connect one end of this wire to lug #2. Solder and route to the rear.

( ) Cut and prepare a 4-1/2" (11.5 cm) length of insulated wire. Connect one end of this wire to lug #3. Solder and route.

( ) Cut and prepare a 4" (10.2 cm) length of wire. Connect one end to lug #4. Solder and route.

( ) Cut and prepare a 2-3/4" (7 cm) length of insulated wire. Connect one end to lug #6. Solder and route.

( ) Cut and prepare a 6" (15.3 cm) length of insulated wire. Connect one end to lug #7. Solder and route.

( ) Cut and prepare a 5" (12.7 cm) length of insulated wire. Connect one end to lug #8. Solder and route.

( ) Cut and prepare a 4" (10.2 cm) length of wire. Connect one end to lug #9. Solder and route to the rear.

( ) Using a nutdriver or pliers, remove the L shaped mounting brackets on the rear edge of the keyboard mainframe. Turn the brackets around so the small foot is facing towards the front of the keyboard instead of the rear. Remount the brackets with the original metal screws.

Temporarily set the keyboard aside while we construct some additional subassemblies which will be mounted on the keyboard.

( ) Locate the uninsulated wire provided and cut a length 17-1/4" (43.8 cm) long. Use a pair of pliers to straighten out any bends or kinks which may be present.

( ) Locate the hollow plastic tubing and cut four (4) four-inch (10.2 cm) lengths.

( ) Select 5 of the 1N914 (or 1N4148) signal diodes. Prepare these diodes by cutting the cathode lead (from the banded end of the diode) to a length of 3/8" (1 cm). After cutting, use a pair of needlenose pliers to form a small U at the end of the cathode lead. Place the cathode lead of one diode around the previously

cut uninsulated wire. Slide the diode fully to one end of the bare wire and solder. Use a minimum amount of heat during the soldering process as diodes can be damaged by subjecting their leads to soldering temperatures for more than 5 seconds or so. For additional safety, we recommend the use of a heat sink on the diode lead between the body of the diode and the solder connection.

( ) Select one of the four-inch lengths of hollow tubing and slip it over the free end of the long bare wire. Slide the tubing down until it is within 1/8" (3 mm) of the solder joint just made.

( ) Select anouther of the prepared diodes and in a similar manner mount it right next to the tubing just installed. Solder this connection.

( ) Repeat the above procedure until you have a complete diode bus consisting of four length of 4" rubber tubing, and 5 diodes. The final assembly should look like figure 8.

( ) Set aside this diode bus and repeat the entire procedure FOUR more times - thus making a total of five diode busses each with five diodes mounted on it.

( ) Cut three 13" (33 cm) length of the bare wire. Using these wires, construct three more diode busses each using four diodes and three 4" (10.2 cm) lengths of hollow tubing. These three busses are constructed exactly like the previous five. See figure 8.

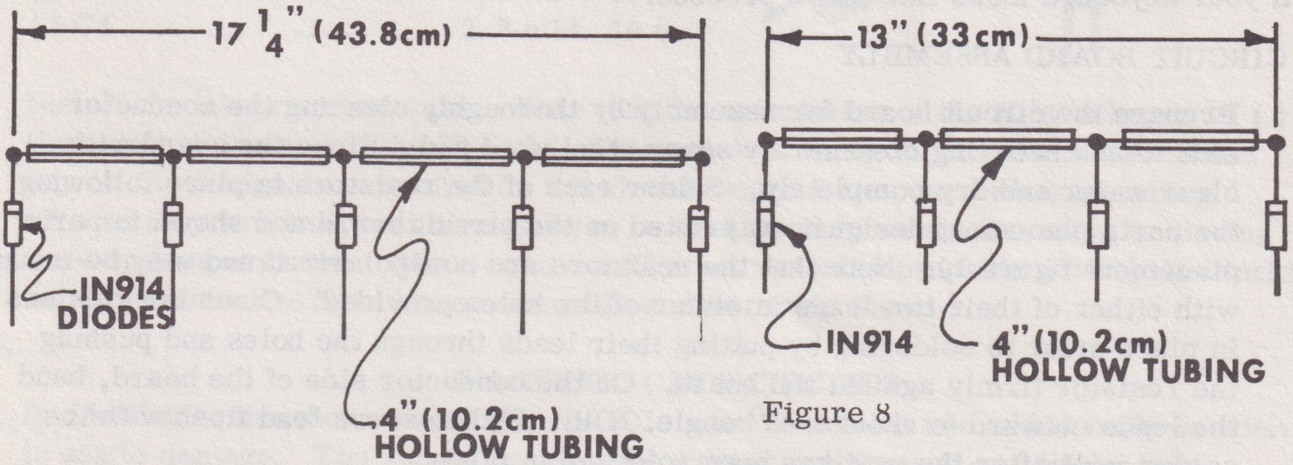


Figure 8

( ) Now that you have an arsenal of diode busses, move the keyboard subassembly back to your workspace and orient it upside down with the rear of the keyboard facing you (exactly like you had it before). We will now mount the diode busses on the rear of the keyboard. Refer to figure 9.

( ) Note that the leftmost terminal of the keyboard circuit board will not be used. Starting with the second terminal from the left, use a pencil to lightly number the first eight terminals 1 through 8. Repeat this numbering pattern until you have four groups of eight terminals, and a fifth group numbered 1 through 5.

( ) Select one of the longer diode busses previously constructed. Lay the diode buss along the rear of the keyboard circuit board such that the five diode leads are in line with the five terminals numbered "one". Allowing approximately 1/4" (7 mm) of diode lead between the body of the diode and the terminal, wrap the diode lead one turn around the keyboard terminal. Repeat this for all five diodes. Solder these five connections, remembering to heat sink the diode leads to avoid damage. Once soldered, clip the excess diode lead close to the soldered connection.

( ) Locate the length of insulated wire which has one end connected to lug #1 of the right terminal strip. The free end of this wire should already be stripped and tinned. It is important that this wire be tinned before connection.

( ) Lay the tinned end of this wire against the junction of the first diode buss wire and the diode furthest to the right of the keyboard. While holding this wire in place, heat the connection with the soldering iron and allow the solder to flow between all three wires. Hold the wire in place while allowing the joint to cool. Route the wire neatly around the corner of the keyboard circuit board.

( ) Select another of the long diode busses constructed earlier. Following the same procedure outlined above, mount the second diode buss. The only difference will be that the diodes will be connected to the keyboard terminals numbered "2", and the wire from lug #2 of the right terminal strip will be used.

( ) Similarly install long diode busses three through five.

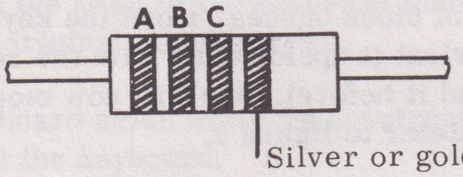
( ) Diode busses six through eight will use the short style busses. Otherwise, these are installed as above.

This completes the keyboard subassembly.

The keyboard should have no unconnected wires. The five sections of the long gold buss rod should be connected to the left terminal strip. The rear of the keyboard circuit board should be supporting an array of staggered diode busses such that there is one diode connected to each of the 37 rightmost solder terminals. The right ends of these diode busses should be wired to the right terminal strip. If your keyboard looks like this - proceed.

CIRCUIT BOARD ASSEMBLY

( ) Prepare the circuit board for assembly by thoroughly cleaning the conductor side with a scouring cleanser or soapy steel wool pad. Rinse the board with clear water and dry completely. Solder each of the resistors in place following the parts placement designators printed on the circuit board and shown in parts placement figure 10. Note that the resistors are non-polarized and may be mounted with either of their two leads in either of the holes provided. Cinch the reistors in place prior to soldering by putting their leads through the holes and pushing the resistor firmly against the board. On the conductor side of the board, bend the leads outward to about a 45° angle. Clip off the excess lead flush with the solder joint after the part has been soldered in place.



Silver or gold - disregard this band.

DESIGNATION	VALUE	COLOR CODE A-B-C
( ) R1	10K	brown-black-orange
( ) R2	150K	brown-green-yellow
( ) R3	150K	brown-green-yellow
( ) R4	2700 ohm	red-violet-red
( ) R5	10K	brown-black-orange
( ) R6	150K	brown-green-yellow
( ) R7	470 ohm	yellow-violet-brown

( ) Using the bare wire provided, form and install the 16 jumper wires as indicated by the solid lines in figure 10 and on the circuit board.

Install the ceramic disk capacitors. The values will be marked on the body of the component.

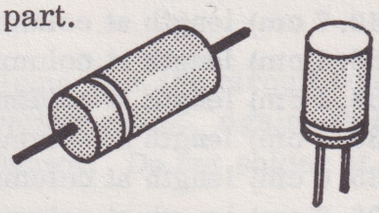
DESIGNATION	VALUE
( ) C1	.005 mfd.
( ) C2	.01 mfd.
( ) C5	.05 mfd.

Up to this point all components have been non-polarized and either lead could be placed in either of the holes provided without affecting the operation of the unit. Electrolytic capacitors are polarized and must be mounted so that the "plus" lead of the capacitor goes through the "plus" hole on the circuit board. In the event that the "minus" lead of the capacitor is marked, it should go through the unmarked hole on the circuit board.

Note that the specified operating voltage (v.) is only a minimum rating. Capacitors supplied with the kit may have a higher voltage rating, but can be used without affecting operation of the unit. For instance, a 100 mfd. 25 v. capacitor may be used in place of a 100 mfd. 16 v. capacitor.

Mount the electrolytic capacitors and solder them in place. Their values, rating, and polarization are marked on the body of the part.

DESIGNATION	VALUE
( ) C3	2.2 mfd. 10 v.
( ) C4	2.2 mfd. 10 v.



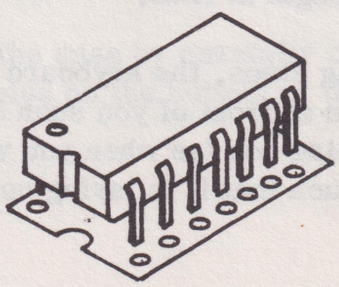
Install the integrated circuits. Note that the orientation of the IC's is keyed to the notch at one end of the IC body. This notch is lined up with the semicircular key on the designators printed on the circuit board. Use care when installing IC's as they are heat sensitive and can be destroyed by using excessive soldering time or temperatures. Make sure the IC's are oriented properly prior to soldering, as the devices are hard to remove without destroying them.

WARNING: CMOS CIRCUITS

In addition to the above warnings, the IC's used in this kit are additionally sensitive to static damage. You should not experience any problems if you follow these precautions:

1) The circuits are supplied to you in a block of conductive foam. Leave the IC's in these holders until you are ready to install the part.
2) Do not install the IC's in sequence other than that called for in the instructions.
3) Do not wear synthetic (nylon, rayon) clothing while handling these parts.
4) A three wire grounded soldering iron is ideal but if you don't have one your present one may be used by first allowing it to heat, then UNPLUGGING it during the actual soldering process. Before soldering and after unplugging, touch the tip momentarily to the ground screw of an electrical outlet to drain static charges.

The IC's can now be mounted.



DESIGNATION	VALUE
( ) IC1	CD4024
( ) IC2	CD4051
( ) IC3	CD4051
( ) IC4	CD4001
( ) IC5	CD4001

In the following steps wires will be soldered to the circuit board that in later steps will connect to the keyboard and front panel. At each step, cut the wire to the length indicated and strip 1/4" (7 mm) of insulation from each end. Twist the exposed wire strands together and tin them by melting a small amount of solder into the strands.

( ) A 14" (35.6 cm) length at row 0.
( ) A 14" (35.6 cm) length at row 1.
( ) A 14" (35.6 cm) length at row 2.
( ) A 14" (35.6 cm) length at row 3.
( ) A 13" (33 cm) length at row 4.
( ) A 13" (33 cm) length at row 5.
( ) A 13" (33 cm) length at row 6.
( ) A 13" (33 cm) length at row 7.
( ) A 16" (40.7 cm) length at column 0.
( ) A 15" (38.1 cm) length at column 1.
( ) A 15" (38.1 cm) length at column 2.
( ) A 15" (38.1 cm) length at column 3.
( ) A 14" (35.6 cm) length at column 4.
( ) A 14" (35.6 cm) length at column 5.
( ) A 14" (35.6 cm) length at column 6.
( ) A 14" (35.6 cm) length at column 7.
( ) A 22" (55.9 cm) length at point A.
( ) A 22" (55.9 cm) length at point B.
( ) A 14" (35.6 cm) length at "+" (nearest the edge of the board).
( ) A 14" (35.6 cm) length at "÷" (nearest the edge of the board).
( ) A 24" (61 cm) length at DO (pin 1 of the I/O cluster).
( ) A 24" (61 cm) length at D1.
( ) A 24" (61 cm) length at D2.
( ) A 24" (61 cm) length at D3.
( ) A 24" (61 cm) length at D4.
( ) A 24" (61 cm) length at D5.
( ) A 24" (61 cm) length at START.
( ) A 24" (61 cm) length at $\overline{\text{SCN}}$.
( ) A 24" (61 cm) length at $\overline{\text{STR}}$.
( ) A 24" (61 cm) length at STR.
( ) A 24" (61 cm) length at RST.
( ) A 24" (61 cm) length at "÷".
( ) A 24" (61 cm) length at "+".
( ) A 24" (61 cm) length at $\overline{\text{RND}}$.

During the following steps, the keyboard and circuit board will be wired together. Orient the keyboard in front of you such that it is laying upside down with the rear of the keyboard facing you (as when you were constructing the keyboard). Orient the circuit board such that it is laying upside down (copper side up) between you and the keyboard.

( ) Locate the free end of the wire connected to row 0 on the circuit board. Connect this wire to lug #1 (nearest the front of the keyboard, farthest from you) of the leftmost terminal strip on the keyboard. There should be no other wire connected to this lug at this time. Do not solder at this time.

( ) Cut and prepare a 12" (30.5 cm) length of insulated wire. Connect one end of this wire to lug #1 of the leftmost terminal strip. Solder two wires. The free end of this extra wire will be connected to the front panel at a later time.

( ) Similarly, connect the row 1 wire to lug #2 of the same terminal strip. There should be one additional wire already connected at this point. Solder this connection.

( ) Connect the row 2 wire to lug #3 of the left terminal strip. Solder.

( ) Connect the row 3 wire to lug #4. Solder.

( ) Connect the row 4 wire to lug #6. Solder.

( ) Connect the row 5 wire to lug #7. Solder.

( ) Connect the row 6 wire to lug #8. Solder.

( ) Connect the row 7 wire to lug #9. Solder.

( ) Locate the free end of the wire connected to column 0 on the circuit board. Connect this wire to lug #1 of the rightmost terminal strip. Again, this will be the terminal lug nearest the front of the keyboard. Do not solder at this time.

( ) Cut and prepare a 34" (86.4 cm) length of insulated wire. Connect one end of this wire to lug #1 of the right keyboard terminal strip. Solder three wires. The free end of this extra wire will connect to the front panel at a later time.

( ) Connect the column 1 wire to lug #2 of the right terminal strip. Solder this connection.

( ) Connect the column 2 wire to lug #3. Solder.

( ) Connect the column 3 wire to lug #4. Solder.

( ) Connect the column 4 wire to lug #6. Solder.

( ) Connect the column 5 wire to lug #7. Solder.

( ) Connect the column 6 wire to lug #8. Solder.

( ) Connect the column 7 wire to lug #9. Solder.

The keyboard is now fully wired and ready to be mounted in the case.

( ) Locate the case subassembly. Prepare the case by carefully cutting away the vinyl covering the four #8 countersunk holes on the bottom of the case.

( ) Insert a #8-32 X 1" flat head bolt in the two holes nearest the front of the case. Place a #8 flat washer over each bolt from the inside of the case, followed by a #8 star lockwasher and a #8 nut. DO NOT fully tighten the nuts at this time. The nuts must remain loose enough to allow 1/8" of space between the large flatwasher and the case bottom. The front flange of the keyboard will slide into this space.

( ) Turn the keyboard/circuit board assembly over, and lay it in the case bottom. Slide the keyboard forward making sure the front flange of the keyboard slides under the large flatwashers on the front keyboard mounting bolts. See figure 6.

( ) Orient the two groups of NINE wires between the circuit board and keyboard such that they pass around the outside of the 2 rear keyboard "L" mounting brackets.

( ) While holding the keyboard firmly against the case bottom, carefully tip the case forward so that it is setting on it's front edge. Pass the two remaining #8 X 1" bolts through the rear keyboard mounting holes. These bolts screw directly into the keyboard "L" brackets. Tighten the two rear keyboard mounting bolts. Tighten the two front keyboard mounting bolts. All four keyboard bolts should be quite tight to prevent any keyboard motion during transport.

( ) Using four #4 X 3/4" screws and four 5/16" spacers, mount the circuit board such that the rear edge of the board is 1" (2.6 cm) from the rear case side and and the left edge of the board is 17" (43.2 cm) from the left case side.

( ) Locate the free end of the wire connected to the "+" hole nearest the front edge of the circuit board. Connect this wire to lug #7 of the power supply terminal strip. Solder the four connections at this point.

( ) Locate the free end of the wire connected to "⏚" on the circuit board. Connect this wire to lug #4 of the power supply terminal strip. Solder three wires at this point.

FRONT PANEL ASSEMBLY

( ) Locate the metal front panel and lay it face down on a soft rag to avoid marring the finish.

( ) Select the DB-25S pin socket. Using two #4-40 X 1/4" machine screws, two #4 lockwashers, and two #4-40 nuts, mount the socket in location J1 as shown in figure 11. Make sure the socket is oriented as shown before mounting.

( ) Select the single pole slide switch (S4) and mount as shown using two each 4-40 X 1/4" machine screws, #4 lockwashers, and 4-40 nuts. Orient as shown in figure 11.

( ) Select the double pole 3 position slide switch (S3) and mount in a manner similar to the previous step.

( ) Select one of the mini-pushbutton switches and mount in position S1 as shown. Use the lockwasher and nut provided with the switch, with the lockwasher located between the rear of the panel and the switch.

( ) In a similar manner, mount pushbutton switch S2.

( ) Select the 500K potentiometer (R8) and mount as shown in figure 11. Use two 3/8" nuts, one behind the panel as a spacer, and the second as the mounting nut in front of the panel. Orient as shown before mounting.

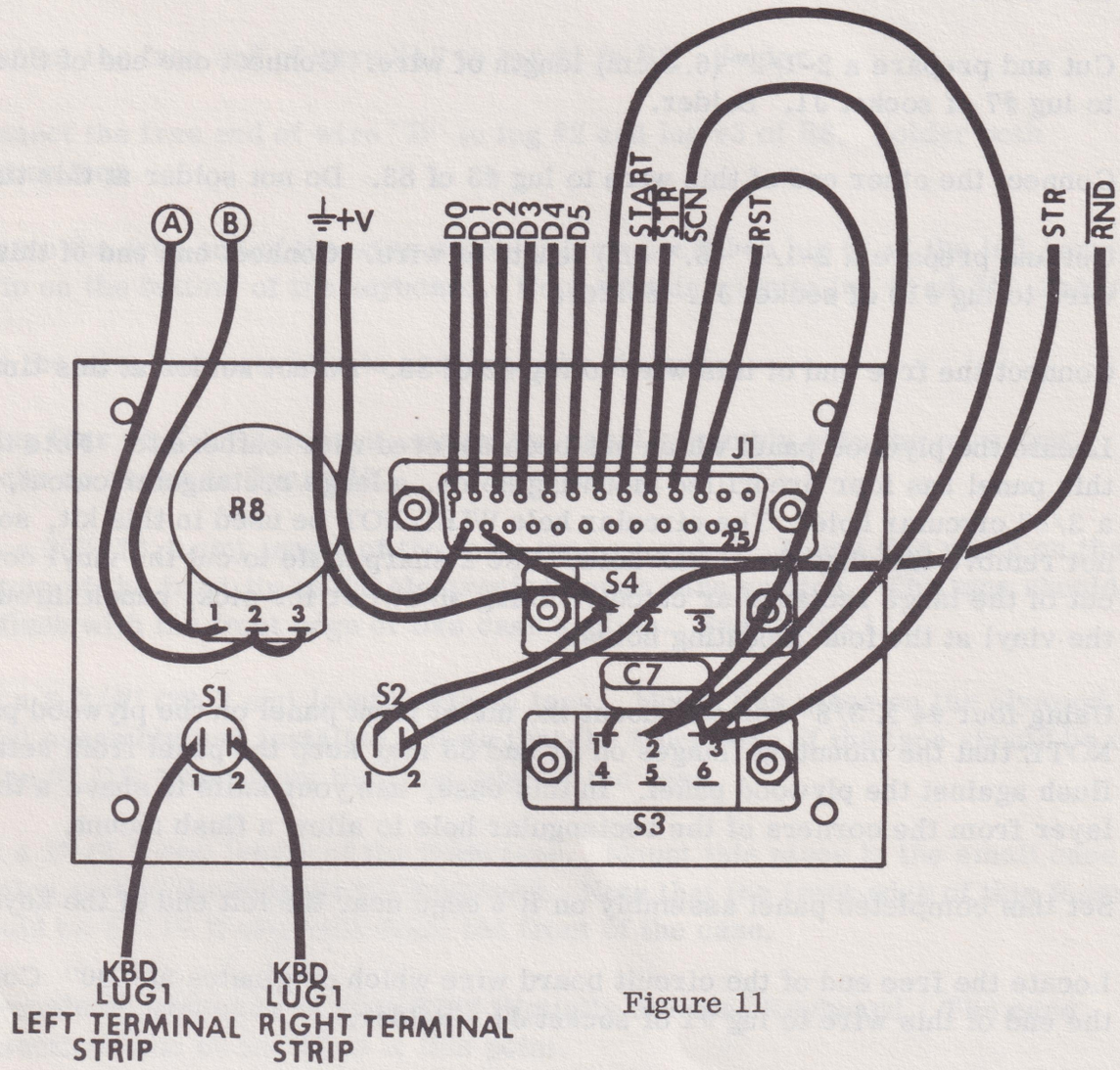


Figure 11

( ) Cut each lead of the .22uf mylar capacitor (C7) to a length of 1/2" (1.26 cm). Connect this capacitor between lug #1 of S3 and lug #3 of S3. Solder only the connection at lug #1.

( ) Cut a 2" (5.1 cm) length of insulated wire. Prepare the ends of this wire by stripping 1/4" (7 mm) of insulation from each end. Twist the exposed strands of wire together and tin them by flowing a small amount of solder into the exposed strands. Connect one end of this wire to lug #1 of S2. Solder.

( ) Connect the remaining end of the above wire to lug #1 of S4. Do not solder.

( ) Cut and prepare another 2" (5.1 cm) length of wire. Connect one end to lug #2 fo S2. Solder.

( ) Connect the free end of the above wire to lug #2 of S4. Do not solder at this time.

( ) Cut and prepare a 1-1/4" (3.2 cm) length of wire. Connect one end of this wire to lug #15 of socket J1. Solder this connection, making sure there are no solder bridges or possible shorts.

( ) Connect the remaining end of the above wire to lug #1 of S4. Do not solder at this time.

( ) Cut and prepare a 2-1/2" (6.3 cm) length of wire. Connect one end of this wire to lug #7 of socket J1. Solder.

( ) Connect the other end of this wire to lug #3 of S3. Do not solder at this time.

( ) Cut and prepare a 2-1/4" (5.7 cm) length of wire. Connect one end of this wire to lug #10 of socket J1. Solder.

( ) Connect the free end of this wire to lug #2 of S3. Do not solder at this time.

( ) Locate the plywood panel which has been covered with leatherette. Note that this panel has four predrilled mounting holes, a large rectangular cutout, and a 3/8" circular hole. The circular hole WILL NOT be used in this kit, so do not remove the vinyl from this hole. Use a sharp knife to cut the vinyl covering out of the large rectangular cutout. Using an awl or ice pick, punch through the vinyl at the four mounting holes.

( ) Using four #4 X 3/8" screws mount the metal front panel on the plywood panel. NOTE that the mounting flanges on J1 and S3 may keep the panel from setting flush against the plywood panel. In this case, use your knife to shave a thin layer from the corners of the rectangular hole to allow a flush mount.

( ) Set this completed panel assembly on it's edge near the left end of the keyboard.

( ) Locate the free end of the circuit board wire which originates at "D0" Connect the end of this wire to lug #1 of socket J1. Solder.

( ) Connect the free end of wire "D1" to lug #2 of J1. Solder.

( ) Connect the free end of wire "D2" to lug #3 of J1. Solder.

( ) Connect the free end of wire "D3" to lug #4 of J1. Solder.

( ) Connect the free end of wire "D4" to lug #5 of J1. Solder.

( ) Connect the free end of wire "D5" to lug #6 of J1. Solder.

( ) Connect the free end of wire "STR" to lug #3 of S3. Solder 3 wires.

( ) Connect the free end of wire "START" to lug #8 of J1. Solder.

( ) Connect the free end of wire "$\overline{\text{STR}}$" to lug #9 of J1. Solder.

( ) Connect the free end of wire "$\overline{\text{SCN}}$" to lug #2 of S3. Solder two wires.

( ) Connect the free end of wire "RST" to lug #11 of J1. Solder.

( ) Connect the free end of wire "+" to lug #14 of J1. Solder.

( ) Connect the free end of wire "⏚" to lug #1 of S4. Solder three wires.

( ) Connect the free end of wire "$\overline{\text{RND}}$" to lug #2 of S4. Solder two wires.

( ) Connect the free end of wire "A" to lug #1 fo R8. Solder.

( ) Connect the free end of wire "B" to lug #2 and lug #3 of R8. Solder both connections.

( ) Locate the free end of the wire which was connected to lug #1 of the left terminal strip on the bottom of the keyboard. Connect this wire to lug #1 of S1. Solder.

( ) Use the wire ties provided to neatly bundle the wires.

( ) Using four #4 X 3/4" screws, mount the panel assembly onto the mounting blocks as shown in figure 12.

( ) Cut a 30" (76.2 cm) length of the foam tape provided. Mount this piece on the bottom of the front lip of the electronics cover case section. The tape should be flush with the front edge of this case section. See figure 12.

( ) Cut a 8-3/4" (22.2 cm) length of foam tape. Mount this piece on the plywood panel assembly just installed. Note that the front edge of the tape should be on a line 6" (15.2 cm) from the front edge of the case.

( ) Cut a 1" (2.5 cm) length of the foam tape. Mount this piece in the small case section just to the right of the keyboard. Note that the front edge of this foam should be 6" (15.2 cm) back from the front of the case.

This completes assembly of your 8782 Digitally Encoded Keyboard. The case cover sections can be installed at this point.

Proceed with the testing and operation sections of the manual.

TESTING

The 8782 Encoded Keyboard is most conveniently tested using the displays on the face of the 8782 D/A control panel as a test instrument, but may also be tested using various processors as described in the software supplement to this manual.

Begin by mating the male "D" connector of the 8780 with the matching connector on the 8782 control panel. (note that power for the displays as well as switching logic in the 8780 D/A are provided by the 8782 Encoded Keyboard's internal power supply).

You may want to connect the Control Voltage output of the 8780 D/A to a Voltage Controlled Oscillator and the output of the VCO, in turn, to an audio amplifier - but this is not essential to the tests to be performed.

Set the NORM/RND and STOP/DELAY slide switches on the 8782 control panel to their NORM and STOP positions respectively. The setting of the TEMPO control is not important at this point.

Plug the power cord from the 8782 Encoded Keyboard into a convenient wall outlet and observe that in all probability some of the LEDs on the face-plate will light (though there is also a possibility that all will remain extinguished).

Press the Special Function (SF) push-button on the 8782 control panel and observe that the LED for the first trigger flag (D6) on the panel of the 8780 lights while the key is held down and extinguished when the key is released. NOTE that it is also normal for the second trigger flag (D7) to randomly be either lit or not lit as the SF key is pressed but that NONE OF THE DATA LEDs (D0 - D5) should light. In fact, in all of the following test steps, it will be normal for the second trigger flag to be randomly lit or not lit.

Now, beginning with the lowest C key on the keyboard, press each key in turn and observe that the 8780 LEDs show the first trigger to be activated (while the key is down) and that the six data lights (D0 - D5) are all extinguished with the exception of D3 which should be lit.

Progress up the keyboard pressing each key (including accidentals) in turn and observing that the LED "count" in the normal binary sequence:

001000 - C
001001 - C#
001010 - D
001011 - D#
001100 - E
001101 - F
001110 - F#
001111 - G
010000 - G#
etc. up to
101100 - C (the last key)

If you have a VCO connected to the output of the D/A, it should be producing a pitch corresponding to each key on the keyboard.

Slide the NORM/RND switch to the right (RND) and observe that the LEDs on the face place of the 8780 wink in random patterns at a rate proportional to the setting of the TEMPO control. NOTE that in the random (RND) mode, the first trigger flag (D6) should not light. If the control voltage output of the D/A is connected to a VCO, you should be hearing random notes during this test.

Return the NROM/RND switch to the NORM position and, with the TEMPO control set to approximately mid-range, press the RND push-button and observe that for each press of the button, a random note is indicated (and/or heard) by the LEDs on the 8780. If the RND button is held depressed for any appreciable length of time, its effect is identical to sliding the NORM/RND switch to the RND position.

Finally, slide the STOP/DELAY switch fully to the right (notice that this is a three position switch) and press the lowest C on the keyboard. Under these conditions, D6 should be lit (while the key is down- and it will actually be blikning very rapidly) D7 should be winking on and off many times a second (though at an observable rate) and D3 should be lit with no evidence of blinking.

Note that this delay mode of operation is intended as a quasi-polyphonic mode and is not intended for playing single notes. When a single note is played in this mode the keyboard may from time to time add an extraneous note. Press down

the first C on the keyboard and the next higher C simultaneously and observe that D2, D3 and D4 wink but that the remaining three DATA indicators show no change (With a VCO connected, you should also hear the oscillator changing between thes two C's.)

Successful completion of these tests provide a high degree of assurance that the Encoded Keyboard and Digital to Analog Converter are properly communicating with one another.

USING THE PAIA 8782 DIGITALLY ENCODED KEYBOARD

The 8782 Keyboard has been carefully configured to be used either as part of an essentially drift-free, digital sample and hold apparatus for conventional analog synthesizers or as an interface between a computer system and the AGO environment with wich all musicians are familiar.

Switching from one application to another is simply a matter of un-plugging one system and plugging in another.

DIGITAL SAMPLE AND HOLD APPLICATIONS

In a music system without the digital computer/processor, the combination of the 8782 Encoded Keyboard and 8780 Equally Tempered Digital to Analog Converter replace the standard keyboard/analog S/H circuitry.

The wiring schedules provided for the female and male, respectively DB-25 type connectors allows the 8780 D/A to plug directly into the OUT connector on the 8782.

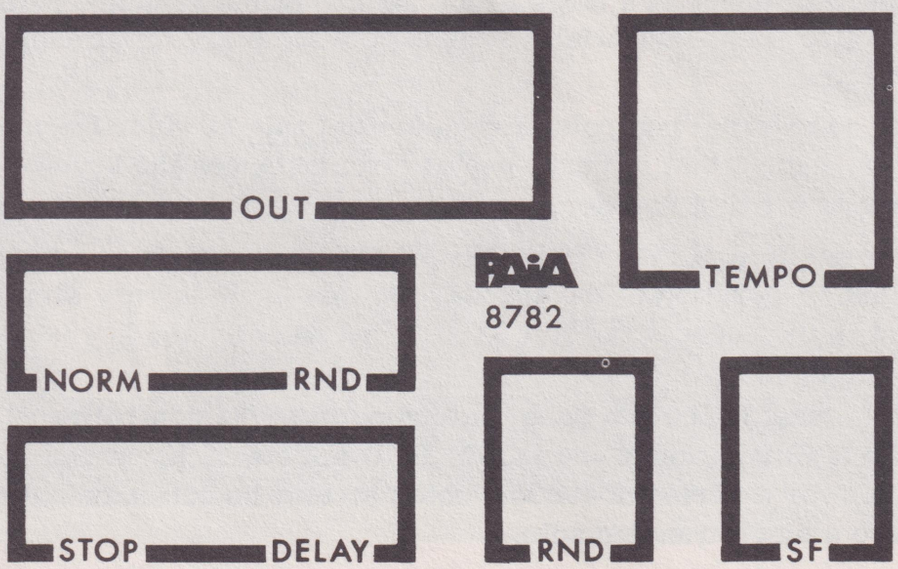


figure a. Panel Graphics.

Under these conditions, the 8782 controls perform the following functions:

OUT The 25 pin, "D" type connector in the upper left hand corner of the panel provides convenient connections to all of the control inputs and data outputs of the 8782. While a 25 pin connector here provides more connections than will ever be reasonably needed to the keyboard, this connector was selected to be consistent with that provided on the 8780 D/A, which will in its ultimate con-

figuration make use of most of the connection points.

NORM/RND This two position slide switch directly below the "D" connector selects either the normal mode of keyboard operation (NORM), or a special mode of operation which causes the keyboard to generate random notes. Sliding the switch to the RND position enables the random note generator (see also later section on 8780/8782 uses)

TEMPO This knob in the upper right hand corner of the control panel provides a control over the rate at which random notes are generated when the NORM/RND switch is in the RND position - and will also serve as a tempo control for some (but not all) of the special effects generated by the keyboard.

STOP/DELAY This three (3) position slide switch in the lower left hand corner of the control panel provides essentially three separate modes of operation for the keyboard:

STOP - The left-most position of this slide switch is the most "normal" mode of operation. With the switch in this position, the combination 8780 and 8782 will behave in essentially the same manner as a conventional analog S/H device. In this mode of operation, the keyboard will "hold" the last note played, ignoring any further key activations until the key currently being played is released.

DELAY - With the switch set to its rightmost position, you are operating in a mode that many people confuse with polyphonic. Unlike the STOP mode, which causes the keyboard scanner to stop completely when a note is found down, the DELAY mode causes the encoder to stop only momentarily, issue a command to the D/A to play the note currently down and then after a short delay go looking for any other keys that are down. The result is an arpeggiation (of sorts) of all of the keys that are currently activated on the keyboard. If the keys that are activated form an interval or triad, the individual notes will be heard in turn. If a large group (or all) of the keys are held down at once, the effect is a sequentially stepping up-scale arpeggiation of all of the notes activated.

There are no external controls to regulate the rate at which the arpeggiation takes place, except that in very special circumstances the keyboard's TEMPO control can serve this function.

The center position of this STOP/DELAY switch is reserved for computer applications. Operation of the keyboard in this mode is very similar to delay (that is the encoder doesn't STOP when an activated key is found) except that there is no delay.

RND This left-most of the two push-buttons on the 8782 control panel is a duplicate of the RND position of the NORM/RND slide switch. It can be either pressed and held for a series of random notes or may be activated only momentarily to produce a single random note.

S. F. The SF is a Special Function key which occupies the "zero key" position in matrix. This key has significance only in computer-based systems where its function is defined by whatever program is currently running on the computer.

DESIGN ANALYSIS

See Lab Notes, "Computer Music Without The Computer".